The lead-lag relationship between the rubber price and inflation rate: an evidence from Malaysia

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Abstract

The objective of this paper to study the causality between inflation and rubber price in Malaysia. This study is the first attempt to investigate the causality by applying Auto Regressive Distributive Lag (ARDL) model which has taken care of a major limitation of the conventional co-integrating tests which suffer from pre-test biases between the variables. Error Correction Model (ECM) using ARDL approach, Variance Decompositions (VDC) technique and Impulse Response Functions (IRF) are also applied to test the exogeneity and endogeneity of the variables and reaction of these variables when a shock is imposed on them. The data used in this study are monthly data from Datastream comprising of inflation rate (CPI as the proxy), Malaysian rubber price: SMR20 and SMR10, Thailand rubber price, US synthetic rubber price and exchange rate. From the study, it is noted that inflation leads the Malaysian rubber price, Thailand rubber price, synthetic rubber price and exchange rate, respectively. This has an important policy implication for the national policy makers and rubber regulators in developing rubber industry in Malaysia.

Keywords: Rubber, Inflation, Synthetic, ARDL, ECM, VDC, Malaysia

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1.0 Introduction: the issue motivating the study

Rubber has been one of the most important commodities in the history of Malaysian economy. Malaysia is the world's fifth largest producer of natural rubber after Thailand, Indonesia, Vietnam and China. The government plans to increase the country's global market share in this sub-sector to 65 percent by 2020 and to produce high-technology and high value-added products under its 2050 National Transformation efforts. In order to achieve that, government needs to look into the stability of rubber price as well. In terms of rubber price, it has reached the highest price in 2010, RM15/kg but severely decline to RM5/kg at November 2017 (Figure 2 & Figure 3) and the fall of the price became a concern to the government. In view of that, we opined that an extensive study should be done by the economist on rubber industry. Despite the importance of rubber industry to Malaysia, there are still lack of studies conducted on the effect of macroeconomic variables on the price of rubber in Malaysia. One study conducted by Sadali.N (2013) revealed that inflation, crude oil and export have positive and significant relationship with rubber price but with the 'import' variable shows a negative relationship. Khin et.al (2016) concluded that the RSS4 (Sri Lankan rubber) price Granger-cause changes the price of SMR20 (Malaysian rubber) and exchange rate with unidirectional causality relationship. They have also examined relationship between rubber price and economic and non-economic variables and found that crude oil price and the stock, supply, demand, synthetic rubber and natural rubber (SMR20) prices are co-integrated. On the reason of selecting inflation as one focus variable, we noticed that the rubber price is experiencing a declining trend, whilst inflation is increasing, we believe our intuition that there could be a causality relationship between both variables as explained in section 6.

Nevertheless, to the best of our knowledge, there is no study done on the causal relationship between rubber price and inflation in Malaysia. The above studies, excepting Khin et al (2016), focus on the determinants of the rubber price but what we are interested in the lead-lag relationship which would help policymakers deal with the fluctuation of rubber price. This is the main issue motivating the paper. Our concern is whether inflation is actually leading rubber price or the other way around. It might be that the rubber price actually leads the inflation rate.

In terms of development of rubber industry in Malaysia, exports of natural rubber was recorded 1.1 million tonnes in 2015 but also decline of 10.7% to 1.0 million tonnes in 2016.

Nevertheless, despite the declining trend, Malaysia is still a net exporter of natural rubber. Malaysian rubber products are currently exported to various countries globally (Figure 1). The USA, Germany and Japan are the largest importers for Malaysian rubber products, constituting 40% of Malaysia's total exports of rubber products, followed by China, UK, Brazil and Australia. The ability of Malaysia to remain a global supplier of rubber products is not only because of the availability of quality raw materials but is also supported by political stability, research and development (R&D) as well as modern infrastructure.

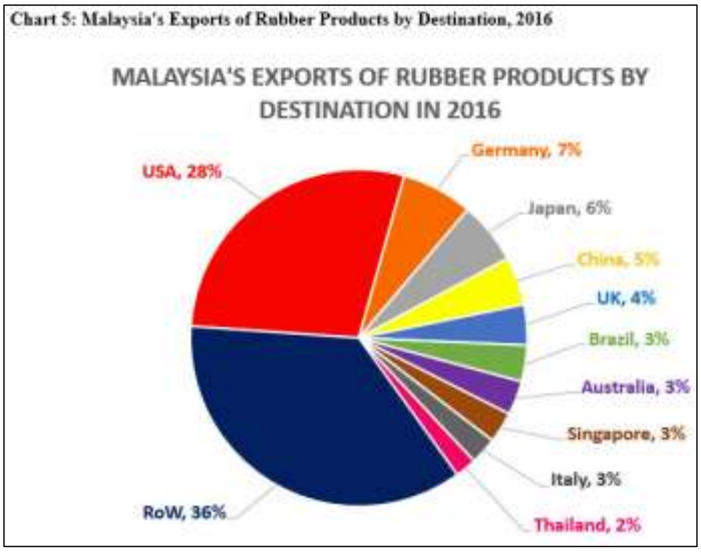
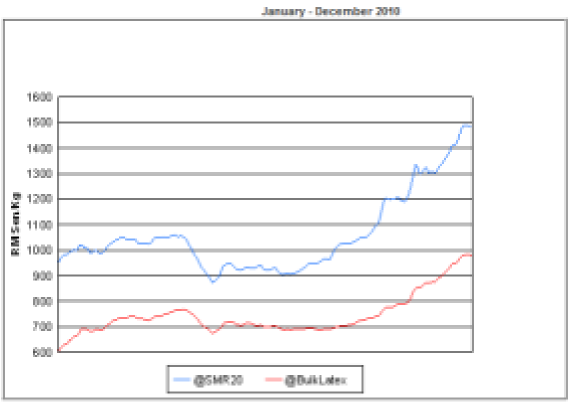
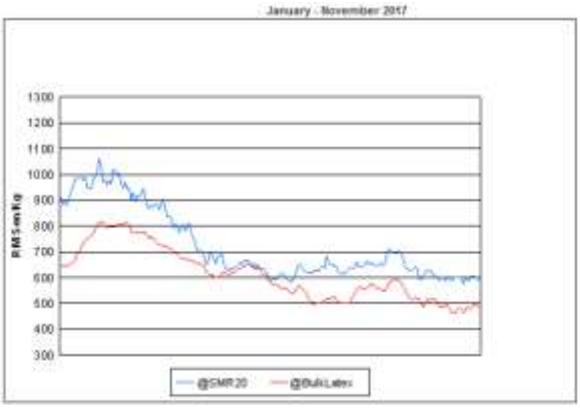


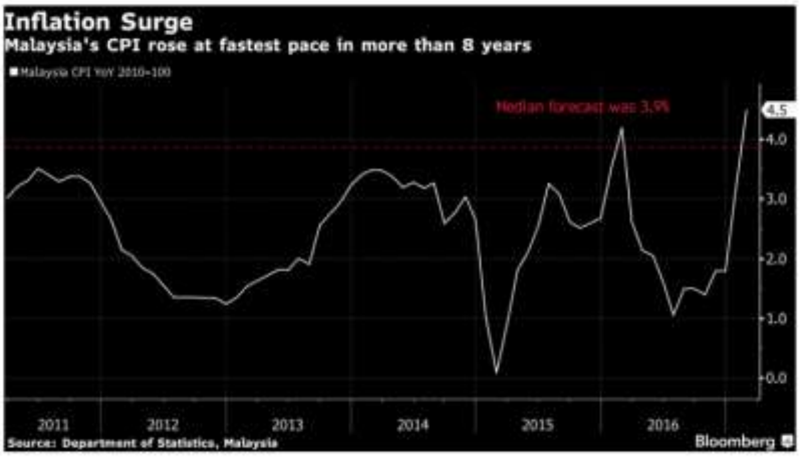
Figure 1 Export of Rubber in 2016

As discussed above, Malaysia is attempting to revive its rubber industry and there are plans to commercialize and to encourage more value-added industries such as latex gloves. Even though there is now the evolution of synthetic rubber, natural rubber is a commodity that could not be replaced by anything else. Obviously, the declining price has affected the income generated from rubber production as the overhead cost may remain high due to its machine-intensive production. The suppliers would be wondering about what factors might be causing the volatility of the rubber price. Generally, we know that commodity markets are subject to shocks to demand and supply and the effect of the macroeconomic variables such as inflation, exchange rates, import and export as well as fundamental factors such as, changes in government policies (**Evenett & Jenny, 2012).**





On inflation side, Malaysia has been containing inflation below 4% for more than 5 years (Figure 2) but it has reached 4.5%, the highest in more than eight years and surpassed the median estimate of 3.9 percent in a Bloomberg survey. Higher fuel costs probably pushed up Malaysia's inflation rate. Central Bank has been keeping the overnight policy rate to stay at 3 percent to support the economy.



For the purpose of this study we use Auto Regressive Distributive Lag (ARDL), Error Correction Model (ECM) using ARDL approach, Variance Decomposition (VDC) technique and Impulse Response Function (IRF) and the detail of the methodology is explained in Section 5. From the study, it is noted that inflation leads the Malaysian rubber price (SMR20, SMR10), Thailand rubber price, synthetic rubber price and exchange rate, respectively.

This paper has seven sections. Following this chapter of introduction, the remaining parts of the paper are organized as follows: Section 2 provides literature review; Section 3 will discuss the objective of this study, Section 4 is on theoretical underpinnings, data and methodology will be discussed in Section 5. The empirical findings and discussion will be reported in Section

6. Finally, the conclusion will be discussed in Section 7.

2.0 Literature Review

There are no literature review specifically on the relationship between rubber price and inflation rate, however, we have several studies done on the commodity price-inflation relationship. The research are relevant in this paper because commodity prices do demonstrate common characteristics which is due to high substitution elasticities, they may portray co-integration, the price variance are more than other markets prices markets (Evenett & Jenny, 2012). Various studies has shown that commodities are leading indicator of inflation. In a study done by Humpage (2011) reveals that commodity prices adjust faster even in anticipation of monetary policies as compared to the prices of other goods and services which are slow to respond. As a result, economists often consider commodity prices that drive inflation through two basic channels. Furlong (1995) explained that firstly, the quick response to general economic shocks, for instance, an increase in demand and secondly is that the changes in commodity prices reflect idiosyncratic shocks. Commodity prices are more flexible than overall prices and in case of system wide shock, commodity prices would increase before other prices. Suardi et.al (2012) performed linear and nonlinear causality tests to examine the causal relationships between changes in commodity prices and U.S. inflation. They found that there is evidence that changes in commodity price indices linearly lead inflation before the period of Great Moderation but there is a stronger bivariate link established before the Great Moderation. Furthermore, there is a proof of significant nonlinear causality from metals indices and raw industrials to inflation. Zhang (2017), through Granger causality test also found evidence of causality from both inflation and output to commodity prices in certain sub-periods. Mahdavi et al (1997) found some evidence of co integration between commodity prices and the consumer price index (CPI) using error correction model (ECM). Using a cointegrating VAR framework and US data, Brown F and Cronin D (2007) concluded that the commodity prices have explanatory power on consumer price inflation.

Nevertheless, the commodities-inflation leading relationship does not always hold as changes in the demand for commodities relative to manufactured goods would lead both prices to move in opposite directions. For instance, an increase in the demand for manufactured goods relative to agricultural products could lead to a rise in overall inflation but a decline in commodity prices. Hence, the effectiveness of commodity prices as inflation indicators depends upon various channels at certain period of time. Furlong (1995) suggested that there could be possibilities of the relationship between commodity prices and inflation to change over time. This can be seen from the evidence of commodity prices as leading indicators of inflation during the 1970s and early 1980s when there was high inflation. Yet, commodity prices have not been a good indicators of inflation after 1980s, when inflation became low with the commodity prices itself were volatile. Thus, it is questionable whether commodities prices can still lead the inflation in the current economy.

3.0 Theoretical Underpinnings

Inflation can be defined as a sustained rise in the general price level of goods and services in an economy over a period of time. The increase of price level will reduce purchasing power because each unit of currency can now buy fewer goods and services. There are three major types of inflation: Demand pull-inflation, Cost-push inflation and Built in-inflation. The main focus of this paper is on rubber being one of a commodity in Malaysia, however, there is no specific literature on relationship between rubber and inflation. Therefore, we will discuss theoretical argument between general commodities and inflation, instead.

There are many factors that causes inflation however, commodity prices are debated to be leading indicators of inflation as commodity prices normally determined in highly competitive auction markets and subsequently incline to be more flexible than prices of goods (Furlong, 1996). Therefore, movements in commodity prices would be expected to lead and have positive relationship with changes in aggregate price inflation in response to aggregate demand shocks. Generally, the cause of commodity shocks have been associated with supply disruptions. Thus, the commodities have tendency to cause high inflation and decreasing output. On demand side, there is an increase of world demand for commodities, especially from emerging markets. The commodity prices can be interpreted as an increase in world relative price of food and energy, which has been particularly strong in countries with a high share of consumption in food and energy. According to Kliesen (1994), theoretically there is a direct relationship between changes in commodity prices and the inflation rate. To illustrate, all other things remain equal, an increase in rubber prices will cause higher tire prices, which in turn may be passed on in the form of higher vehicles prices. This would increase cost of production and later on cause an increase in price of good and services. However, the commodity-inflation linkage does not always hold. An increase in aggregate demand may correspond with an increase in demand for manufactured goods instead of agricultural products. Even though overall prices might increase, prices of agricultural commodities such as rubber might decline.

On contrary, we argued that commodities price do not lead the inflation of an economy of commodity-exporting country, but inflation does. High inflation often brings higher interest rates, which lead to a stronger currency. Our commodities become more expensive and demand for export will fall. Subsequently, this will affect the price of commodities negatively due to reduction in demand. Importers will go for exporting country with weaker currency for purchase of rubber or buy synthetic ones. Thus, inflation drives up commodity prices as the value of the currency eroded affecting the demand for rubber. Inflation will also cause a reduction in purchasing power, and consumers may postpone the consumption on rubber based products such as cars, furniture, mattresses, scuba gears and sports equipment, which will then lead to fall in demand for rubber.

Hence, theoretically, the theory could not give a conclusive answer. Our expectation in this study is the inflation will drive the rubber price. The following section will detail out our model, data and methodology in deriving the empirical result.

4.0 The objective of the study

The primary objective of this study is to examine the causality between rubber price and inflation in Malaysia. The issue is whether inflation is leading or lagging the rubber price. This question will be addressed through the application of Auto Regressive Distributive Lag (ARDL), time-series techniques of vector error correction and variance decompositions. This is considered the first study conducted in Malaysia or even in this region because to the best of our knowledge, there is no attempt by other researchers to investigate the issue of causal direction between rubber price and inflation in Malaysia. Moreover, the theory of commodities prices leading inflation is also arguable. In view of this, we would like to make a humble attempt to obtain the answer to this issue and with hope that the findings of the study will have distinct policy implications for development of rubber industry in Malaysia. The following section will discuss on theoretical aspect of rubber price relationship.

The contribution of this paper are:

i. To the best of our knowledge this study will be the first attempt to investigate the issue as to whether there is any leading-lagging relationship between inflation and the inflation.

ii. The application of the recently developed ARDL Bounds Testing approach which is an alternative to the conventional co-integrating techniques for testing a long-run relationship.

iii. This study will provide important policy implications on Malaysian government, rubber industry authorities and rubber-related market players who will have better understanding of the magnitude and speed of movements of the rubber price in response to changes in the monetary policies.

5.0 Model, Data, and Methodology

5.1 Method of Estimation

The purpose of the paper is to test the lead-lag relationship, therefore, we will begin our empirical testing using Unit-Root Tests to determine the stationarity of the variables used. Subsequently, the order of the VAR will be determined. The next step is to perform the co-integration test to examine the long-run equilibrium relationship and to ensure no spurious relationship among the variables. We then apply the Engle-Granger test to determine the existence of co-integration. However, the test is only able to inform us whether co-integration exist or not between variables. Thus, to determine the number of co-integration exist between variables, Johansen co-integration tests will be applied. Nonetheless, it is only can be carried out if only the first co-integration test, Eager-Granger shows the existence of co-integration. Unfortunately, even though there is co-integration exist in our Eager-Granger test but in earlier Unit Root Test, our variables consist of the combination of I(0) and I(1) which is both stationary and non-stationary, so we could not continue with the Johansen test. In addition, the pre- test such as ADF, PP, KPSS can bias in favour of accepting the null (for example: 95% acceptance level). Therefore, Auto Regressive Distributive Lag (ARDL) approaches is then applied to test the co-integration between the variables. The method was developed by Pesaran et al. (2001).

It is considered to be a relatively more efficient model in testing the variables regardless of the order of their integration because it able to take care of the series that are entirely I(0), I(1) or a combination of both. The ARDL co-integration estimates short run and long run relationship simultaneously and gives unbiased and efficient estimates.

Subsequent test is Vector Error Correction Model (VECM), with the purpose of finding the lead or lag or causality between variables in both short run and long run. Moreover, Error Correction Model (ECM) can also be tested using ARDL approach (Sezgin and Yildirim, 2003). Then, the Variance Decomposition (VDC) technique is performed to indicate the exogeneity or endogeneity of the variable by ranking. The variable that is explained mostly by its own shocks is considered the leader (exogenous) and the least explained is the follower (endogenous). We then use the Impulse Response Function (IRF) to illustrate the exogeneity or endogeneity of a variable in a graph. It is useful for studying the interactions between variables in a vector autoregressive model whereby reactions of the variables to shocks hitting the system can be seen. Finally, the persistence profiles will be applied to estimate the speed with which the variables get back to equilibrium when receive shock.

5.2 Model Specification and Data

In view of the issues noted in the previous section, we want to investigate the possibility of a co-integrating relationship between the rubber price and inflation. Thus, SMR20 is chosen to represent the price as it is the highest grade of rubber produced by Malaysia. In addition to that, we also include Exchange Rate as a control for the state of the economy and two rubber prices: another Malaysian rubber grade SMR10 and Thailand standard rubber price variables to capture competitor's prices and the synthetic rubber price as substitute product to rubber. Exchange rate is used in this model because exchange rates volatility could affect natural rubber prices (Burger et al., 2002, Budiman & Fortucci, 2003).

Monthly time series data are used dated from January 2001 – May 2017 with the total number of observations of 209. All data for this study are collected from Datastream.

The following is a list of the variables employed along with their definitions:

SMR20: Price of standard Malaysia Rubber-Grade 20 per kg

SMR10: Price of standard Malaysian Rubber-Grade 10 per kg

THAI : Price of Thailand Rubber – Metro Grade 1

EXC : Exchange Rate Ringgit Malaysia against USD

SYN : US PPI Synthetic Rubber Price

CPI : Consumer Price Index, a proxy for inflation

Hence, in this study, the ARDL model approach to Co-integration can be expressed as follows:

$$\Delta SMR20_t = \alpha + \sum_{i=1}^{2} \Delta SYN_{t-1} + \sum_{i=1}^{2} \Delta EXC_{t-1} + \sum_{i=1}^{2} \Delta CPI_{t-1} + \sum_{i=1}^{2} \Delta SMR10_{t-1} + \sum_{i=1}^{2} \Delta THAI_{t-1} + (SMR20 - SYN - EXC - CPI - SMR10 - THAI)_{t-1} + \varepsilon t$$

Whereby, α is constant and ε_t is the error term and all of the variables are being transformed to log formed. The empirical result is discussed in the next section.

6.0 Empirical Results and Discussions

6.1 Stationarity tests

The stationarity of the variables are necessary in time series analysis, in order to prevent a spurious regression in the model. Basically, when there is a constant pattern over time or inclination fluctuating around the average value, the data is considered to be stationary (Gujarati, 2009). Therefore, we begin our empirical testing by determining the stationarity of the variables used. We use unit root tests of Augmented Dickey-Fuller (ADF) (1979). The advantage of using ADF is the method can overcome the issue of autocorrelation but it has a weakness which is the inability to solve the problem of heteroskedasticity.

In this study, firstly the ADF test is performed on each variable in both log and differenced form. The differenced form for each variable used is created by taking the difference of their log forms. For example, $DEXC = LEXC - LEXC_{t-1}$.

The results of ADF are tabulated in Table 1.1 and Table 1.2 below for both in level and differenced form respectively.

Table 1.1 Stationarity Test (Level/Log Form)-ADF

VARIABLE	APPROACH	ADF	T-STAT	CRITICAL VALUE	RESULT
LSMR20	AIC	ADF(2)	2.0589	3.4329	NON-STATIONARY
	SBC	ADF (1)	1.8563	3.4329	NON-STATIONARY
LSYN	AIC	ADF(3)	1.4274	3.4329	NON-STATIONARY
	SBC	ADF(2)	1.7704	3.4329	NON-STATIONARY
LEXC	AIC	ADF(4)	0.44699	3.4329	NON-STATIONARY
	SBC	ADF(1)	0.66613	3.4329	NON-STATIONARY
LCPI	AIC	ADF(1)	3.7740	3.4329	**STATIONARY**
	SBC	ADF(1)	3.7740	3.4329	**STATIONARY**
LSMR10	AIC	ADF(2)	2.0603	3.4329	NON-STATIONARY
	SBC	ADF(1)	1.8080	3.4329	NON-STATIONARY
LTHAI	AIC	ADF(1)	2.0434	3.4329	NON-STATIONARY
	SBC	ADF(1)	2.0434	3.4329	NON-STATIONARY

Table 1.2 Stationarity Test (Difference Form)-ADF

UNIT ROOT TEST	APPROACH	ADF	T-STAT	CRITICAL VALUE	RESULT
DSMR20	AIC	ADF(4)	7.0110	2.8759	STATIONARY
	SBC	ADF (1)	7.3656	2.8759	STATIONARY
DSYN	AIC	ADF(4)	6.8943	2.8759	STATIONARY
	SBC	ADF(1)	7.0539	2.8759	STATIONARY
DEXC	AIC	ADF(3)	7.5422	2.8759	STATIONARY
	SBC	ADF(1)	10.0399	2.8759	STATIONARY
DCPI	AIC	ADF(4)	7.0033	2.8759	STATIONARY
	SBC	ADF(1)	7.3523	2.8759	STATIONARY
DSMR10	AIC	ADF(4)	7.2867	2.8759	STATIONARY
	SBC	ADF(1)	8.3056	2.8759	STATIONARY
DTHAI	AIC	ADF(4)	7.3561	2.8759	STATIONARY
	SBC	ADF(1)	8.3406	2.8759	STATIONARY

Based on the above table, the test shows that only one variable is stationary in level form and all variables are stationary in first difference. We then continue with Engle-Granger and Johansen co-integration test. We found that in Engle Granger test there is co-integration between variables and Johansen test shows at least three co-integrating vectors for these variables. Nonetheless, because of the unit root test tests reveal the mixed of I (0) and I (1), we feel uncomfortable to rely on the Engle-Granger and Johansen test result. So, we decided to proceed using ARDL approach to testing for the long run relationship among the variables as it can be applied irrespective of whether the regressors are I(0) or I(1) and this will avoid pre-testing problems if we use standard co-integration analysis.

6.2 Selection of Optimal Lag

Next, the order of the vector autoregression (VAR) is determined where the selection of optimal lag is done based on the highest lag of Akaike Information Criterion (AIC) & Shwarz Bayesian Criterion (SBC). Table 2 shows the result of an optimal lag selection test for SMR20 model. Both AIC and SBC shows a consistent optimal lag number, therefore, we choose lag order for SMR20 model is 2.

Table 2: Optimal Lag

Order	AIC	SBC	Adjusted LR Test [Prob]
6	3452.5	3085.3	-
5	3458.5	3150.9	48.9332[.074]
4	3467.8	3219.6	92.6644[.051]
3	3468.7	3280.2	149.8921[.005]
2	3475.1	3346.1	198.2244[.002]
1	3474.5	3405.1	258.0405[.000]
0	3351.7	3341.7	517.5932[.000]

6.3 Cointegration Analysis

For co-integration test, we applied the ARDL approach. This step is important because an evidence of co-integration will indicate that the relationship among the variables is not spurious, meaning that there is a theoretical relationship among the variables and the variables are in equilibrium in the long run.

The hypotheses are:

H_{null} : there is no co-integration   H0:δ1,δ2, δ3, δ4, δ5, δ6 = 0

$H_{alternative}$: there exists cointegration   H1: δ1,δ2, δ3, δ4, δ5, δ6 ≠ 0

The long run relation between variables in level form are tested using ARDL bound test and the result shows the following:

Table 3: F-Stat results based on 5% Critical Bound

VARIABLE	F-STAT	F-UPPER BOUND	F-LOWER BOUND	RESULT
F(LSMR20|LSYN,LEXC,LCPI,LSMR10,LTHAI)	1.0767	2.003	3.199	Long run relationship does not exist
F(LSYN|LSYN,LEXC,LCPI,LSMR10,LTHAI)	3.2551	2.003	3.199	Long run relationship exist
F(LEXC|LSYN,LEXC,LCPI,LSMR10,LTHAI)	2.8499	2.003	3.199	Inconclusive
F(LCPI|LSYN,LEXC,LCPI,LSMR10,LTHAI)	1.4647	2.003	3.199	Long run relationship does not exist
F(LSMR10|LSYN,LEXC,LCPI,LSMR10,LTHAI)	1.0728	2.003	3.199	Long run relationship does not exist

In identifying the existence of co-integration exists in this bound test, the F statistics from the output is compared the values from F Table developed by Pesaran. If computed F-statistic falls below the lower bound, the null hypothesis of no long run relationship among the variables cannot be rejected. On contrary, if the calculated value is greater than upper bound, we will reject the null hypothesis, so, there is evidence of long run relationship between them. If the value falls between the bound, the result is concluded as inconclusive.

From the table, it is evidenced that there is **one** statistic equation i.e. F (LSYN | LSYN,LEXC,LCPI,LSMR10,LTHAI) shows a long run relationship between variables. This indicates that there is a theoretical relationship among the variables and each variable has information for the prediction of other variables and they are in equilibrium in the long-run. However, this co-integration test do not tell us either the variables are the leaders or followers.. Thus, to answer the question of this paper we have to proceed to the next step which is error correction model.

6.4 Error Correction Model (ECM)

ECM will determine whether a variable is exogenous (leader) or endogenous (follower). As shown in Table 5, the error correction model based on AIC reveals the exogeneity and endogeneity of a variable by looking at the p-value of ECM. The null hypothesis for this test is that the variable is exogenous whenever the p-value greater than 5% critical value and in contract, the variable is concluded as endogenous if the p-value is lesser than the critical value of 5%.

Table 5: Error Correction Model based on AIC

ECM(-1)	CO-EFFICIENT	STANDARD ERROR	T-RATIO[PROB]	CRIT.VALUE	RESULT
DLSMR20	-0.73132	0.090839	-8.0508[0.000]	5%	Endogenous
DLSYN	-0.10623	0.016243	-6.5397[0.000]	5%	Endogenous
DLEXC	-0.083523	0.026976	-3.0962[0.002]	5%	Endogenous
DLCPI	0.010088	0.0079798	1.2643[0.208]	5%	**Exogeneous**
DLSMR10	-1.0000	0.00000	**none	5%	**Exogeneous**
DLTHAI	-0.30706	0.042762	-7.1807[0.000]	5%	Endogeneous

The VECM model can be expressed as follows:

$$\Delta SMR20t = \alpha + \sum_{i=1}^{2}\Delta\ SYN_{t-i} + \sum_{i=1}^{2}\Delta EXC_{t-i} + \sum_{i=1}^{2}\Delta\ CPI_{t-i} + \sum_{i=1}^{2}\Delta SMR10_{t-i} + \sum_{i=1}^{2}\Delta THAI_{t-i} + e_{t-1} + \varepsilon t$$

$$\Delta SYNt = \alpha + \sum_{i=1}^{2}\Delta\ SMR20_{t-i} + \sum_{i=1}^{2}\Delta EXC_{t-i} + \sum_{i=1}^{2}\Delta\ CPI_{t-i} + \sum_{i=1}^{2}\Delta SMR10_{t-i} + \sum_{i=1}^{2}\Delta THAI_{t-i} + e_{t-1} + \varepsilon t$$

$$\Delta EXCt = \alpha + \sum_{i=1}^{2}\Delta\ SYN_{t-i} + \sum_{i=1}^{2}\Delta SMR20_{t-i} + \sum_{i=1}^{2}\Delta\ CPI_{t-i} + \sum_{i=1}^{2}\Delta SMR10_{t-i} + \sum_{i=1}^{2}\Delta THAI_{t-i} + e_{t-1} + \varepsilon t$$

$$\Delta CPIt = \alpha + \sum_{i=1}^{2}\Delta\ SYN_{t-i} + \sum_{i=1}^{2}\Delta EXC_{t-i} + \sum_{i=1}^{2}\Delta\ SMR20_{t-i} + \sum_{i=1}^{2}\Delta SMR10_{t-i} + \sum_{i=1}^{2}\Delta THAI_{t-i} + e_{t-1} + \varepsilon t$$

$$\Delta THAIt = \alpha + \sum_{i=1}^{2}\Delta\ SYN_{t-i} + \sum_{i=1}^{2}\Delta EXC_{t-i} + \sum_{i=1}^{2}\Delta\ CPI_{t-i} + \sum_{i=1}^{2}\Delta SMR10_{t-i} + \sum_{i=1}^{2}\Delta SMR20_{t-} + e_{t-1} + \varepsilon t$$

From the result, it can be seen that there are four endogenous variables in this study; (i) rubber price-SMR20; (ii) US-synthetic rubber price (iii) exchange rate and (iv) Thailand rubber price. CPI as proxy of inflation and rubber price-SMR10 are exogenous variables. Hence, this implies that CPI and rubber price-SMR10 play important roles in determining the changes in rubber price-SMR20. Thus, the theory of commodities prices leading the inflation is not hold in the case of rubber industries in Malaysia. This probably due to rubber is just a smaller portion of total production costs over the time and the inflationary levels in Malaysia reflects increases in the aggregate demand for other bigger portion of goods and services.

The above error correction model can also be used to estimate the speed of convergence to equilibrium. If it is close to zero (in absolute term), there is a slow speed of convergence to equilibrium, otherwise the speed is moderate or fast. The coefficient of ecm(-1) for SMR20 is estimated at -0.73132 is highly significant, has the correct sign and can be considered having a moderate speed of adjustment to equilibrium after a shock. As for CPI, the co-efficient of ecm(-1) is estimated at 0.010088, not significant and has convergence speed which is much more slower than SMR20. This means that the deviation of variables has significant impact on rubber price but not on CPI. Yet, ECM does not really tell us about which variable is the most exogenous as compared to other variables, vice versa. In determining the degree of exogeneity/endogeneity , we need to employ the Variance Decompositions (VDCs) technique to identify the ranking of exogeneity or endogeneity of these variables.

6.5 Variance Decompositions (VDCs)

VDCs are use so that the relative degree of endogeneity or exogeneity of the variables can be determined. It can be examined by the proportion of the variance explained by its past. The variable is considered a leader (exogenous) when it is explained mostly by its own shock. We do not choose orthogonalized VDCs because it assumes that when a particular variable is shocked, all other variables are “switched off”. Orthogonalized VDCs also do not produce a unique solution as it has tendency of reporting first variable with highest percentage, as a result, the first variable normally become the most exogenous. Therefore, for the purpose of this study, generalized VDCs are more preferred than orthogonalized VDCs. The forecast horizon is selected at longer period namely; 80 months, 100 months and 150 months as depicted in Table 6. The contributions of own shocks towards explaining the forecast error variance of each variable for forecast horizon of are slightly different but they provided the same ranking across the horizons. The result concluded that CPI as a proxy of inflation is the most exogenous, then followed by rubber price-SMR20, rubber price-SMR10, Thailand rubber price, exchange rate and lastly US Synthetic Rubber price. This is consistent with the findings in Error Correction Model as CPI is the most exogenous between the variables. Based on this result, we can conclude that inflation lead (rather than lags) the rubber price. This is also in accordance to our expectation. It can be summarised as follows:

EXOGENEOUS

SYN ← EXC ← THAI ← SMR10 ← SMR20 ← CPI

Table 6: The VD Matrix

At Horizon =80

	LSMR20	LSYN	LEXC	LCPI	LSMR10	LTHAI	SELF-DEP	RANK
LSMR20	**34.22**	4.56	0.23	0.52	34.09	26.39	34.22	**2**
LSYN	30.76	**6.87**	3.62	2.53	30.76	25.45	6.87	**6**
LEXC	25.28	2.63	**17.98**	2.68	25.35	26.08	17.98	**5**
LCPI	19.17	3.69	0.16	**43.14**	19.11	14.73	43.14	**1**
LSMR10	34.20	4.56	0.23	0.52	**34.07**	26.42	34.07	**3**
LTHAI	29.90	5.81	1.45	1.59	29.87	**31.38**	31.38	**4**

At Horizon =100

	LSMR20	LSYN	LEXC	LCPI	LSMR10	LTHAI	SELF-DEP	RANK
LSMR20	**34.15**	4.57	0.24	0.70	34.02	26.32	34.15	**2**
LSYN	30.68	**6.84**	3.52	2.97	30.67	25.33	6.84	**6**
LEXC	25.23	2.64	**17.98**	2.86	25.29	26.00	17.98	**5**
LCPI	19.65	3.78	0.14	**41.73**	19.59	15.11	41.73	**1**
LSMR10	34.13	4.57	0.24	0.70	**34.00**	26.35	34.00	**3**
LTHAI	29.72	5.78	1.44	2.23	29.69	**31.14**	31.14	**4**

At Horizon =150

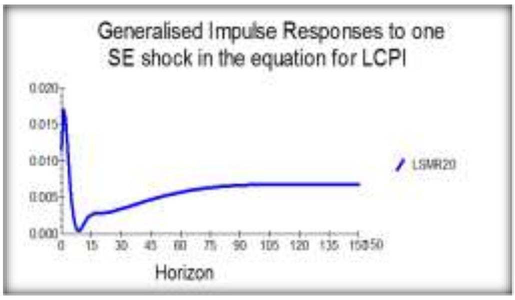
	LSMR20	LSYN	LEXC	LCPI	LSMR10	LTHAI	SELF-DEP	RANK
LSMR20	**33.99**	4.57	0.24	1.16	33.86	26.19	33.99	**2**
LSYN	30.32	**6.75**	3.38	4.28	30.31	24.96	6.75	**6**
LEXC	25.18	2.65	**17.79**	3.23	25.25	25.91	17.79	**5**
LCPI	20.25	3.90	0.11	**39.99**	20.18	15.58	39.99	**1**
LSMR10	33.97	4.57	0.24	1.17	**33.84**	26.21	33.84	**3**
LTHAI	29.33	5.71	1.40	3.69	29.30	**30.57**	30.57	**4**

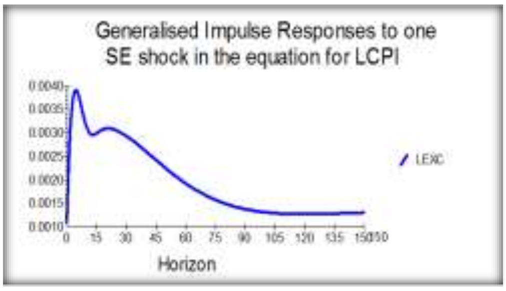
It is noted that VECM shows conflicting result from VDC in terms of the endogeinity/exogeneity of SMR10 and SMR20. In VECM, SMR10 is exogenous variable but in VDC, it is ranked below SMR20 which is endogenous. In my opinion, since both rubber price are differed in terms of grade but the price are very close to each other, they might interchangeably lead or lag each other. In my intuition, result shown by VDC is more reflecting the actual condition as VDC shows causality beyond sample period. The VDC is considered an important tool to make proper assumptions regarding the causal relationship beyond the in-sample period.

6.6 Impulse Response Function (IRF)

Finally, IRF is applied to map out the dynamic response of a variable when one period standard deviation shock to another variable. It gives the same information as the VDCs but in the graphical form. In this study, we would like to examine the impact of other variables when we shock inflation and rubber price. From the graphs in Figure 1&2 shows the impact of the shocks on the other Malaysian rubber price-SMR10, Thailand rubber price, exchange rate, US synthetic rubber price. It can be seen that when inflation are shocked (Figure 1), there are positive and strong reaction from all variables but does not come back to normal over a time horizon of 150. The reaction of rubber price (SMR20) seems to reduce at certain point and getting stronger afterwards. We think that it may take longer time to converge to the equilibrium. When we shock SMR20, exchange rate shows negative response whilst others show positive responses. However, all variables are slowly converging to equilibrium at horizon (month) 9.

Figure 1. Generalised Impulse Response To One SE Shock of LCPI





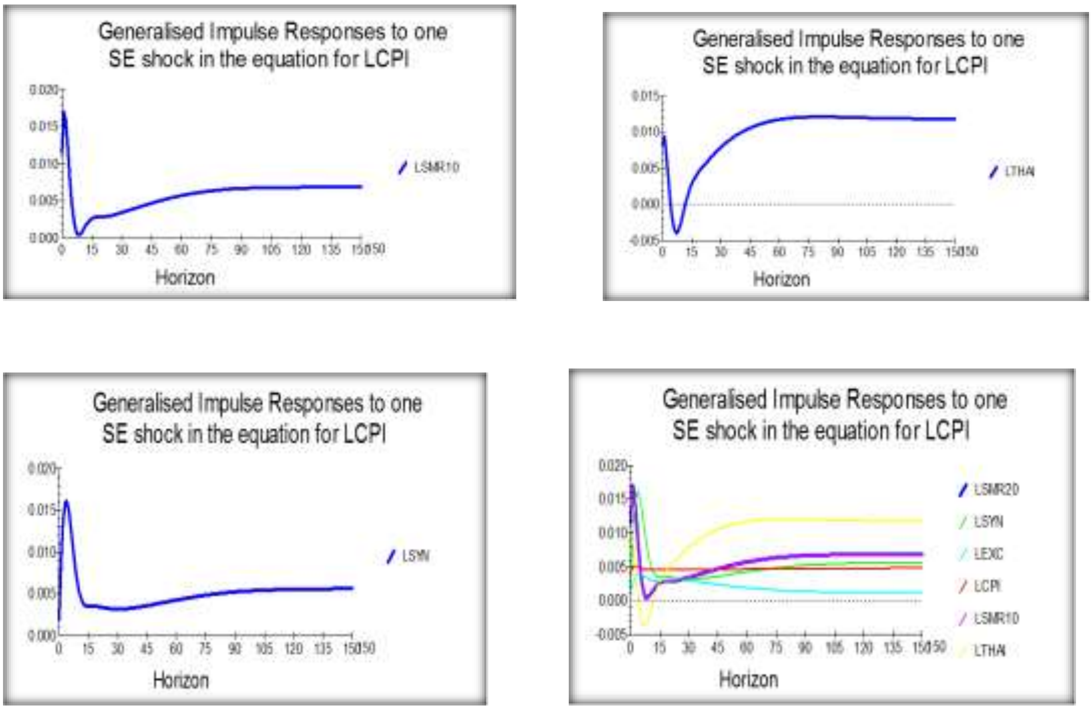
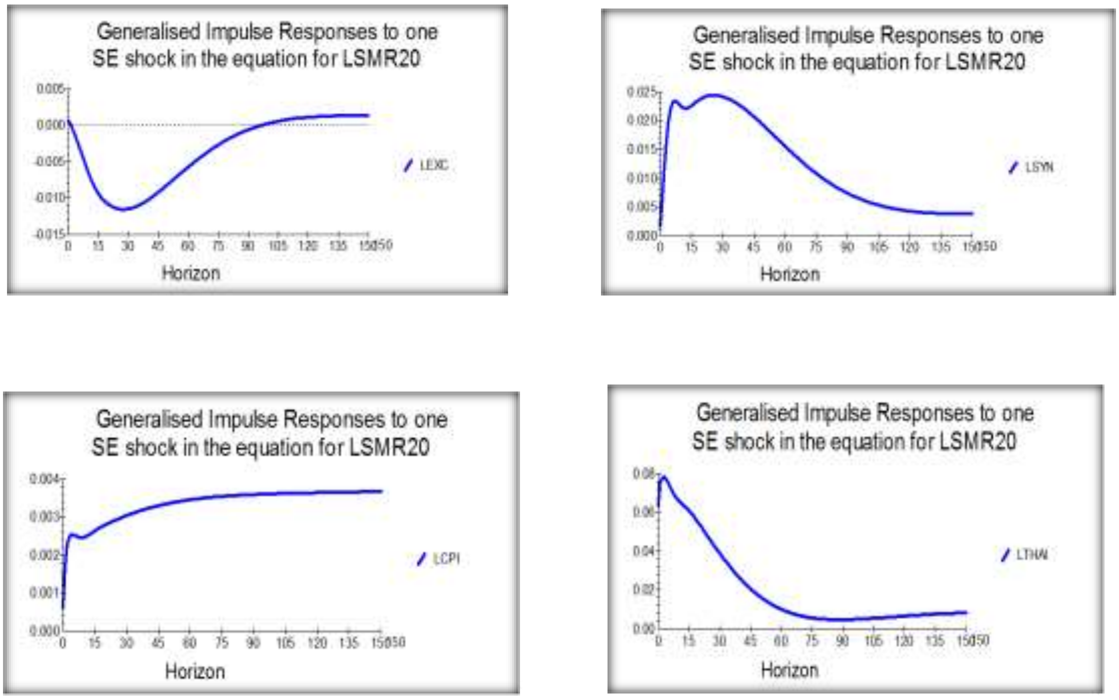
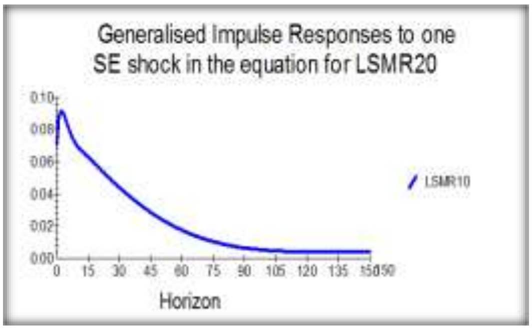
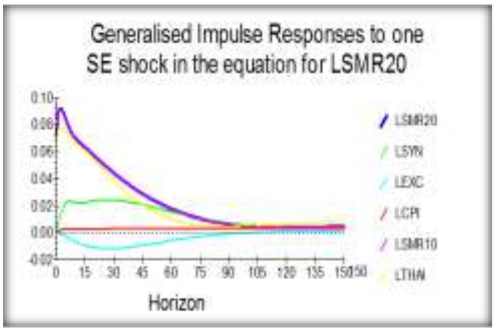


Figure 2. Generalised Impulse Response To One SE Shock of LSMR20







7.0 Policy Implications and Concluding Remarks

The objective of this study is to find the causal relationship between inflation and rubber price in Malaysia. ARDL approach together with ECM, VDC and IRF are applied in this study and the result shows that inflation is the leading factor to Malaysian rubber price (SMR20, SMR10). Another important evidence is that Malaysian rubber price is not led by the competitor's price that is Thailand's rubber as well as US synthetic rubber. This is consistent with a study conducted by Burger K. et al (2002) which conclude that natural rubber leads synthetic rubber price. Our study also conclude that exchange rate does not lead the rubber price.

The causality between rubber prices and inflation suggests a need for policymakers to make an appropriate policy in addressing the government's objective to develop the rubber industry. We have discussed in earlier section that the government plans to increase the country's global rubber market share in this sub-sector to 65 percent by 2020 and to produce high-technology and high value-added rubber products under its 2050 National Transformation efforts. Thus, the stability of rubber price is vital in order to achieve the objectives. Moreover, Malaysian government has expressed their concern on the volatility of the current rubber price which affecting the income of the rubber- tappers and need to be given financial aid to help them meeting their ends.

Inflation is expected to increase until 4.8% this year (Bloomberg, 2017) due to continues rise of oil price. The result has shown that in order to control the rubber prices, the inflation level should be controlled. One of the measure of controlling inflation is through contractionary monetary policy as government will reduce the money supply by increasing interest rates. The effect of this measure is spending will be reduced due to less liquidity, increase savings and less available credit. Hence, inflation can be controlled. Some economist expected that the Bank Negara Malaysia (BNM) might have to raise rates later in the year to keep inflation in check and to avoid potential capital-outflow pressure arises from the U.S. Federal Reserve's tightening policy. On contrary, some economists opined that BNM will maintain the current policy rate. Thus, assuming the interest rate is maintained at current, there is a possibility that the inflation may continue to rise to the expected rate. Therefore, policy maker need to think of ways to stabilize the rubber price amidst of rising inflation. Another measure is by increasing statutory reserve ratio. BNM would be able to control the inflation because it can reduce the capability to give credit to customer. By doing so, it also reduce the money supply in the market and tend to reduce the purchasing power of the costumers. The government may also use fiscal policy by reducing government expenditures and taxes but as for Malaysia, increasing tax is not a good approach because this has become a sensitive issue to the public and political agenda. According to Outlook and Policy report (BNM, 2017) the government has put an effort to reduce non-critical spending and to enhance rationalisation of subsidies. Furthermore, the government will diversify its income sources to maintain its resilience against uncertainties.

Other measure that government could undertake is to control the supply of rubber either individually or working together with other rubber producer such as Thailand and Indonesia through International Rubber Consortium (IRCo). IRCo was established with the objective to promote sustainability of rubber production and the members are Malaysia, Indonesia and Thailand. This approach is not new to the commodity industry, as it was done by Malaysia in its Malaysian Crash Program 1974-1975 where government cut rubber production to control the price. Even the OPEC recently had done the same when the oil price was declining to the bottom. As a result, the oil price has stabilized again. This can be done through implementation of export quota. The government or the Consortium need to decide on the appropriate volume of rubber to be controlled so that buyer will not substitute to synthetic rubber instead. The excess rubber production may be stored at a special warehouse and to be used during shortage of supply. Furthermore, to ensure that producers adhere to the restriction, punitive export quota will be imposed to those exporter who breach the quota. The rubber price then to be reviewed on quarterly or half yearly basis, if the price is not within targeted price, government may need to further reduce the supply.

Secondly, to mitigate the risk of substitution to synthetic rubber which is the major competitor of natural rubber, government should impose heavy import duties on synthetic rubber or excise duties on product using synthetic rubber. Thirdly, rubber price is not only depends on supply and demand but various market conditions such as weather, flooding, socio-political issues can have an impact on price too. Thus to ensure sustainability of rubber production, government must take care of deforestation issue, proper sewerage system and flood management system.

The above policies are on supply-side. On the demand-side, government should establish appropriate natural rubber policies, including setting a suitable area of natural rubber plantation in order to balance supply and demand on the world market which would impact natural rubber price stabilization in the future. Policymaker should make an effort to increase demand and usage of rubber. The Malaysian Rubber Board (MRB) and Public Works Department (PWD) are now studying on the possibility of using rubber on the road. Rubberised road is a mixture of scrap rubber and bitumen and it is more durable. We opined that the rubberised roads should be implemented in Malaysia as it would stabilise prices of natural rubber through domestic consumption. Later, the technology can be commercialized globally and attract demand from other countries.

Monetary tightening to reduce effect of inflation may not address price stability issue but policymakers can design structural policies to improve production as one of long term measures such as through investment grants or tax reliefs to rubber production. Price control is another mechanism that can be implemented by policymakers. However, these structural policies take longer time to be effective.

Finally, we are aware of the limitations in this study which may affect the result. Firstly, we would like to highlight that in this study we only include inflation and exchange rate as economic variables and did not include other important ones such as GDP, amount of rubber export or rainfall which are also believed to have a significant impact on the rubber price. Therefore, it would be a good attempt for future research to incorporate all of these variables to produce a more robust result.

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